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OBJECTIVE RISK LEVELS AND SUBJECTIVE RISK PERCEPTION

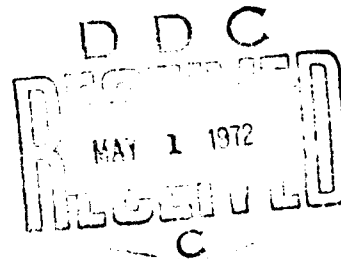
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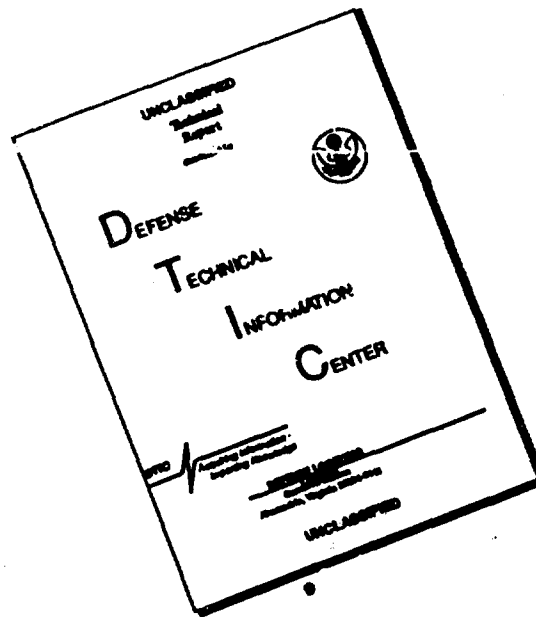
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13. ABSTRACT  The relationship between objective risk levels calculated on the basis of decisions made by subjects in a simulated war and their subjective risk perceptions was investigated. In addition, subjects were informed that greater or lesser amounts of information would reach them, and that greater or lesser quantities of their decisions would reach the destination to which the decisions were addressed. In reality subjects played an experimenter-determined program. No direct relationship between objective risk levels and subjective risk perception was found. Perceived (subjective) risk levels decreased over time, while objective risk levels did not decrease. Persons assigned to a "rebel" team took greater risks (and perceived greater risk taking) than persons assigned to a "large foreign power" team. Risk taking was not related in any way to experimenter statements about information flow.			

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## OBJECTIVE RISK LEVELS AND SUBJECTIVE RISK PERCEPTION

Siegfried Streufert and Captain Eugene A. Taylor

### INTRODUCTION

People make decisions every day of their lives. Many of these decisions contain certain levels of risk. Driving a car, walking across a busy street, investing money, or spending time and energy in hopes of achieving beneficial goals all may contain elements of risk: the outcomes are uncertain, and there is the possibility of injury or loss.

Inherent in decisions of this type are probabilities of success or failure. If all information about a type of decision (e.g., crossing busy streets) were known, a probability of success or failure could be assigned. Unless the objective probabilities of any decision are given and understood, and in most complex decisions they are not, the individual may perceive and utilize some subjective estimate of risk. In most cases this process probably does not occur through careful weighing of probabilities and utilities. However, an individual should be able to indicate (with some degree of accuracy) how dangerous an act might be, i.e., how much relative risk may be involved. When his subjective perception of risk agrees with objective probabilities, a decision maker should be able to make optimal decisions. For instance, the closer a person's estimate of risk involved in crossing a busy street reflects the objective measure of accident statistics, the better his judgment about whether and when to cross the street should be.

#### Definition of Risk

The concept of risk as it is utilized in this paper is based on the proposition that risk occurs in decisions that involve the possibility of loss (Kogan and Wallach, 1967; Pruitt, 1961). Game theory formulations which differentiate between decisions involving risk (probabilities of all alternatives are known and given) and decisions under uncertainty (probabilities are not known) are not considered in this context (cf. Luce and Raiffa, 1957). Following the work of Edwards (1955), Coombs and Pruitt (1960), Pruitt (1962), Lichtenstein (1965), Kogan and Wallach (1967), and Van der Meer (1963), decision making involving risk is here seen as a process in which an individual or a group maximizes a combination of subjective probability and utility where the

alternative exhibiting more variance (higher potential gain or loss) is seen as more risky (assuming that an unfavorable outcome of any decision is possible).

#### Measurement of Risk

A number of different measures that were designed to tap individual differences in risk taking propensity have been proposed. Slovic (1962, 1964) and Kogan and Wallach (1964) have shown that the relationships between the various measures are low or nonexistent. Attempts at relating other personality measures as need for success and fear of failure (Atkinson and Feather, 1966) have had little more success. Apparently people who are risky in one situation or on one measure may not be risky if tested in a different setting or on a different test.

One possible solution to this problem is to ask people how risky they think they are. The obtained scores may then be compared to objective risk measures. The present study uses concepts derived from Pruitt's (1962) PLR model (cf. also Kogan and Wallach, 1967). A complex decision-making environment is selected as the research environment to permit utilizing the concept of the disproportionate negative utility of large losses in this concept of risk. Subjective estimates of risk are compared to increasing variance patterns in objective risk.

#### Objective Measures of Risk

Slovic (1962) gave subjects several tests and questionnaires covering different categories of risk taking in an extensive validation study. Subjects were given tests measuring category width, speed versus accuracy, and gambling response-set, the Williams Job Preference Inventory, Torrence and Ziller's Risk Scale, a vocabulary test in which subjects adjusted the number of points they were willing to risk winning or losing on each item (thus controlling variance), and a test designed to assess probability and variance preferences. In addition, subjects were asked to peer-rate fellow fraternity brothers on a bipolar trait of general willingness to take risks.

Twenty-eight correlations were obtained among measures presumed to be positively related. Of these correlations, only five were significant. Slovic (1962) concluded that either very few of the tests measured risk taking, or that a generalized risk-taking propensity does not exist.

In a more exhaustive review and analysis of validity of risk taking measures, Slovic (1964) examined numerous risk measures under categories of gambling set, inclusiveness set, speed versus accuracy, judgmental measures, questionnaire measures, and probability and variance preference measures. Slovic (1964) concluded (p. 227):

"There are enough positive results to encourage the investigators to further pursue the notion of risk taking propensity as a general disposition.... However, a large amount of evidence bearing on the convergent validity of these methods is negative."

In discussing the negative evidence, Slovic stated (p. 228):

"Observation of choices made among acts entailing various degrees of objective risk cannot distinguish the extent to which risk taking is determined by individual differences in perception of risk or by differences in reaction to that perceived risk. Perceptual differences might take the form of discrepancies among persons' subjective probabilities and subjective values (utilities) and differences in the manner that perceived values of these component dimensions are weighted and combined to produce a resultant evaluation of risk.... Researchers may thus be forced to scale subjective probabilities and utilities in order to allow any orderliness inherent in risk taking behavior maximum opportunity to emerge."

In another survey Kogan and Wallach (1964) sampled a diverse array of task and situational contexts within which risk taking might be studied, to see whether an individual who is a risk taker as measured by one procedure would turn out to be a risk taker when measured by all the procedures. They found relatively little generality across the diverse range of risk-taking tasks represented.

In studying achievement activation, Atkinson (1960) has utilized level of aspiration or expectation measurements as indicators of risk-taking propensity. In a typical task, subjects participated in a ring-toss game in which the distance from which subjects threw a ring supposedly indicated their level of desirability for difficulty, or risk. The results are discussed by Atkinson and Feather (1966, p. 90):

"An issue of fundamental importance that is treated rather inadequately here is the measurement of subjective probability of success. Strong assumptions are made concerning how the chances of success must appear to Ss.... The actual probabilities of success obtained from...Ss in this experiment, while not altogether relevant, since it is probability of success as it

appears to Ss at the beginning of the game that is required to test hypotheses from the risk-taking theory, do nevertheless provide some support for the assumptions made."

The assumptions are that individuals with need for success dominating fear of failure would pick probabilities of success at medium levels of .4 - .5. However, the average observed probability of success was only .23, indicating the possibility of subjective factors operating which were not accounted for in the measure.

#### Summary of Objective Risk Measures

The apparent lack of validity between risk measures seems to indicate serious inadequacies inherent in many of the risk measures. In other words, classifying an individual as risky because he scored toward the "risky" end of an objective measure may be invalid unless subjective perceptions of risk are also known and relate positively to the objective measure. If the individual is using information related to the decision that alters his subjective probability and perception of utility from that assumed in the objective risk measure, then the extent to which a score reflects the individual's riskiness is questionable.

A measure of subjective perception of risk, then, could be a valuable asset in validation of any arbitrary objective measure. An objective measure of risk would be valid only to the extent that it incorporated those dimensions which are perceived and utilized by the decision maker.

#### Comparing Objective and Subjective Risk Measures

In an extensive review of risk taking and decision making, no comparisons were found between objective measures of risk in decision making and subjective estimates of risk as perceived by the decision maker.

To establish support for the feasibility of comparing objective and subjective risk, it will be beneficial to examine studies comparing objective and subjective probability. While it is acknowledged that these probability measures are not exactly equivalent to their respective measures of risk, a close relationship exists. An objective risk measure utilizes a set of objective probability values, and an individual, in deciding whether to take a certain course of action, often may subjectively consider the probability of success and failure of that action.



Edwards (1962) proposed that a set of functions can be arrived at relating subjective probability (SP) to objective probability (OP). Edwards develops his idea in this manner (1962, p. 115):

"...each event to which a decision theory might be applied has certain as yet unspecified characteristics which determine its SP. One of these characteristics is, of course, OP, whenever OP is defined. The others are unknown: this paper will call them identifying characteristics."

Similar events have similar identifying characteristics which are influential. Mathematically, Edwards (1962) conceives of SP as a function of OP and of identifying characteristics. Events with similar OPs and similar identifying characteristics should have similar SPs. Edwards (1962) uses a formula with a non-additive SEU model in which SPs do not need to reach unity.

Shuford (1959) performed an experiment in which Ss viewed square matrices of 400 red and green thumb tacks. Ss were very accurate in estimating relative frequency of each color. SP approached OP.

Edwards (1959) utilized similar matrices in a probability preference experiment. Subjects estimated relative frequency of each color and then chose one of two bets, which had probabilities of winning based on frequencies of occurrence of the component colors. Ss did not choose bets with the highest probability of winning, though estimates of relative frequency were excellent. Edwards concluded that people perceive OPs correctly but often misuse them by not optimizing this information while betting.

Davis, Hoppe, and Hornseth (1969) conducted an experiment in which subjects made a decision to accept a known outcome (win or lose one unit) or to take a risk and accept the consequences of an alternative event (win or lose 2, 3, 4, ..., 11 units) unknown at the time of decision. Risk-taking patterns were detected in which strategies of subjects were influenced by expected value, variance, and level of risk. A clear preference was shown by subjects for middle-value strategies combining high EV and high variance. Extreme strategies were avoided, including the one containing the optimum EV.

Comparative studies on horse race betting have been reported where final odds were treated as subjective probabilities (Griffith, 1949; McGlothlin, 1956), as a relation between money bet on each horse versus total amount bet. Objective probabilities were the actual outcomes. Although SP - OP relationships were obvious, bettors did not take advantage of the lowest and highest probabilities.

Munson (1962) found persons betting in a carnival situation perceived and utilized objective probabilities in betting and chose optimal bets in relation to an Expected Value Model.

Cohen (1960) had English football players estimate probability of success in kicking a football through the goal posts at different distances in a skill-type task. The players then performed the task to obtain measures of actual probability. The estimates were very accurate, coinciding well with the actual probabilities.

Results of the studies discussed above seem to provide support for the contention that individuals can accurately estimate varying levels of risk among alternatives involving simple tasks where the parameters are few and known, even when making more complex decisions if enough information is known and correctly utilized.

#### Effect of Information on Risk

When making complex decisions under conditions of uncertainty, where objective probabilities are not known, a decision maker is forced to rely on whatever information is available. He must decide whether and when he has an optimal amount of knowledge to act upon. To the extent that he does not have an adequate amount of information he may not be able to accurately comprehend the situation and will be taking a certain amount of risk when arriving at a final choice (assuming the possibility of a negative outcome).

Studies relating information to risk in decision making are typically ones in which a subject is required to make a decision about which there are a given number of bits of information available. The more information the subject has, the higher the probability of making a correct decision. When rewards are given for correct decisions and each bit of information costs money, a measure of risk is involved to the extent that the subject makes a choice with less than total information in order to maximize gain.

In an experiment by Irwin and Smith (1957), Ss were asked to estimate whether the mean of numbers in a deck of cards was above or below zero, when each card seen cost the subject money and a correct answer received a prize. Number of cards requested by an S was directly related to the value of the prize and inversely related to the monetary cost per card.

Pruitt (1961) used this same procedure in relating the actual amount of information desired by a S and an optimal amount specified by an expected value theory. He used an apparatus programmed to yield a sequence of red and green lights. The subject made a decision whether the machine was biased toward red or green. Pruitt found large individual differences, though the sample mean (of requests) was close to the optimal value.

Edwards and Slovic (1965) conducted a similar experiment with monetary incentives based on an optimum information-probability strategy. Their Ss picked the optimal strategy only 34% of the time and also showed large individual differences.

Lanzetta and Kanareff (1962) utilized decision problems much more real-life oriented than the previous studies. Using 25 information-seeking problems with a high degree of social content, this study provided a monetary incentive for correct answers and a cost for information. Five possible information bits were inversely related to probability of payoff with decisions based on no information having a zero probability of winning, and a decision using all five bits of information having a probability of winning of one. They found information search was directly related to value of the prize and inversely related to cost.

Hoge and Lanzetta (1968) examined the effects of subjective uncertainty and amount of information. Subjects made decisions concerning problems in which there were differing amounts of available information. Confidence scales were marked by the subjects after each decision, and decision times were recorded. Objective values of response uncertainty were calculated from the distribution of choices using an information theory formula for average uncertainty.

The data showed that subjective uncertainty was closely related to the objective measure of response uncertainty; increases in response uncertainty produced decreases in confidence in decision, and increases in decision time.

The authors stated (p. 1087):

"The prediction that subjective uncertainty would be affected by the degree of knowledge factor was confirmed, though it is apparent that the relationship is a complex one. While both the size of the set of known data items and the size of the set of unknown data items had a significant effect on confidence, there were indications that the proportion of known to total items forms the true basis for the effect. Such a finding is reasonable if it can be assumed that the source of the effect relates, as with response uncertainty, to the individual's perception of the effect of this factor on the probability of making a correct choice. Within the situation employed here, the ratio of known to unknown items appears to offer the best standard against which to compare the relative values of the various matrices in leading to the correct choice."

These studies point to several conclusions. First, subjects seem to take more risk when information is costly in terms of money or time required to make the decision. Also large individual differences were found, implying that maximization models do not seem to apply, and pointing to differences in subjective estimates of successfully arriving at the correct decision, or differential perception of amount of risk involved. Secondly, the amount of information available affects the degree of subjective uncertainty and confidence in a decision.

#### Risk Taking in Complex Environments

Studies involving more complex decision-making environments have related information load (total amount of information) to information search and utilization (Streufert, Suedfeld, and Driver, 1965; Suedfeld and Streufert, 1966), to decision-making complexity (Streufert and Schroder, 1965; Streufert, Driver, and Haun, 1967), to rate of unintegrated and retaliatory responses (Streufert et al., 1967), and to risk taking (Streufert and Streufert, 1968).

These last studies have used a complex simulated game environment involving an international conflict situation, where subjects must make decisions concerning events and activity related to the game. Subjects use information provided them by experimenters during the course of the simulation to produce decisions related to various aspects (military and economic) of the game. Player decisions affect outcomes, and rewards-losses are experienced as direct results of actions taken. Tactical and strategic decisions are made based on differing amounts of information and under various degrees of uncertainty.

The studies utilizing this simulation indicate that there is a certain "optimal" level of information load and that decision makers operating under this optimal load condition make "better" decisions. It was found that these

optimal load conditions produced more complex, integrated, strategic, and well-planned decisions, and fewer unintegrated, retaliatory, and inappropriate responses.

These "better" decisions, made under optimal load conditions, also involved higher levels of risk as determined by an objective measure in which risk increased with number of men committed in battle, or with amount of money spent or invested in an economic endeavor. There were costs and rewards related to information quantity. If too much time was consumed in obtaining information before making a decision, the opportunity could be lost for winning a military engagement or receiving returns on economic investments. On the other hand, it could also be costly if a decision were made without enough information.

The concept of risk used in these studies is related to the amount of information utilized in making decisions. In the more simple tasks there was a certain desirable amount of information which afforded an optimal strategy for maximizing gains. Decisions based on less information increased the risk level and decisions based on more information limited the rewards. In the complex simulation task higher levels of measured risk were attached to optimal information loads.

#### Present Research

The Pruitt model has been fairly well substantiated in research dealing with simple gambling and decision tasks, in which variance preferences have been noted and where large variance patterns have been avoided because of an undesirable level of risk attached to losing. The subjective perception of risk was observed to increase as variance became greater, reaching a point where cost of losing became prohibitive.

A logical progression would be to use the Pruitt model in determining the extent to which risk is perceived to increase with variance when making more complex decisions, i.e., those containing the element of uncertainty found in real-life situations where total information about the alternatives is not known. The present study uses Pruitt's PLR model in this kind of environment, comparing an objective measure of risk to subjective perception of risk.

The task for this study provides a controlled laboratory environment in which complex decision making is required of the subjects. An objective measure of risk related to the Pruitt model has been employed in previous research utilizing this environment.

## METHOD

### Subjects

One-hundred and twenty-four male undergraduate students from courses in psychology at Purdue University participated as paid volunteers in an experimental pre-programmed simulated international conflict situation. Sixty dyad decision-making teams were formed in which the members acted as equal rank commanders with responsibility for making decisions regarding the military, economic, and intelligence environment.

### The Task

The Tactical and Negotiations Game (TNG) experimental simulation is an international conflict environment (with characteristics similar to Vietnam) and is described in Streufert, Kliger, Castore, and Driver (1967). Teams were told that they would play a tactical and economic game against equivalent decision makers representing the opposing forces, and that the experimenters would arbitrate as judges. In reality, however, all functions of the "enemy team" were programmed and performed by the experimenters, insuring exposure to standardized inputs. Subjects were free to make decisions and utilize available resources within the limitations outlined by their respective instruction manuals.

One-half of the dyads participated in the game from the position of the Union of Northern Hemispherical States (UNHS), a large outside power cooperating with the military government controlling the simulated country of "Shamba." The remaining dyads took the position of the Free Republic of Shamba (FRS), an indigenous army supported by a neighboring neutral country, attempting to establish their own control through force.

The Ss spent the initial two hours of the experiment studying a players manual of relevant information about the history and nature of the conflict and the current political, military, and economic conditions. The manual contains equivalent information and instructions for both sides, although the development is slightly different for the UNHS and FRS, being oriented toward attitudinal support of the respective positions. In addition to familiarizing the teams with the situation and available resources, the reading period provided a similar two-hour pre-experimental environment for the participants.

Identification with, and orientation toward, the Ss' particular position in the game was enhanced by a detailed relief map of the country, displaying

initial location of both friendly and enemy troops, and by locating appropriate flags, national symbols, and progress charts in various parts of the room.

All dyads participated in the simulation for five consecutive 30-minute periods. To avoid an end effect, teams were not told which period would be their last. During each period, the subjects received ten written messages spaced in equal time intervals: 60% of the messages were neutral in content, and 40% of the messages communicated success. The initial experimental period was a warm-up period. Messages for the experimental periods contained information on the military, economic, intelligence, and negotiations situation and were oriented toward the developments occurring as the game progressed.

The teams of Ss made written decisions on appropriate decision forms and included statements of purpose and rationale for the decision.

Short interim periods occurred after each playing period. During these periods the subjects filled out reports and responded to various scales.

Subjects were not aware or suspicious of the actual role of the experimenters on communicating programmed inputs. In previous research, Streufert and Streufert (1969) established that subject attribution of causality to experimenter influence has consistently been well below 20%.

#### Objective Measure of Risk

The objective measure of risk used in this study was the same as that defined and used in previous research involving the TNG (e.g., Streufert and Streufert, 1968). Decisions were classified as risky based on the decision context described by the subject on the decision form. For the purposes of this research, only those decisions involving military activity were considered. Decisions considered risky were aggressive rather than defensive in nature, i.e., initiating possible contact with enemy troops, or placing troops or equipment in positions where they could be in danger of attack by enemy forces. Decisions not considered risky were those involving (1) preparatory moves, in anticipation of later moves involving contact with the enemy; (2) retaliatory moves, e.g., defending or meeting offensives initiated by the enemy; and (3) withdrawal moves, in which retreats from precarious situations were ordered, or moving troops to locations not involved in conflict.

This concept of risk was used as the objective measure because decisions based on this same criterion were classified as risky in previous simulation

research. It is thought that decisions meeting these criteria contain clearly understood conditions of possible riskiness with a minimum of ambiguity in interpretation.

The number of men specified on a decision form and ordered into a combat position or engagement defined as risky was used as raw data for the analysis of military risk taking. In the context of risk as developed in this paper, the level of risk is assumed to increase with the number of men committed to a position in which the possibility of loss of troops and equipment exists.

#### The Subjective Measure of Risk

The subjective perception of risk used was taken from the military decision forms classified as risky by standards described above, and from which the objective measures were obtained. On each decision form the subject responded to the question: "How risky is this decision?" The S marked a 1-7 point scale on which the perceived inherent risk in the decision ranged from low to high.

#### Manipulation of Perceived Information Quantity

This manipulation was induced by an experimenter operating as an independent information source, e.g., simulating the functions of intelligence agents, spies, organization agents, etc., with alliance toward either the UNHS or the FRS.

The teams were called by this experimenter at the start of each playing period and this statement read to them:

"This is UNHS (or FRS) intelligence. Intelligence sources estimate that due to the current situation in Shamba, only \_\_% of your communications will reach their destination, and likewise only \_\_% of the messages sent to you will reach you."

At the start of the first playing period all teams received the messages with 90% inserted in the blank spaces. In the four remaining periods the teams were informed that estimates were either 20%, 40%, 60%, or 80%. The teams received all four of the percentage estimates; their order varied randomly for each team. The first period, considered a warm-up period, was not used for data analysis involving the "percent of information" variable.

In reality, the percentage estimates did not affect the information flow, and the subjects received all ten messages programmed for each period.



## RESULTS

A one-way ANOVA was performed to compare subjective risk with objective risk. The PLR model of risk suggests that in the TNG environment risk level should increase with number of men committed in an offensive engagement or as variance in amount of possible gain/loss increases. If subjective risk is closely related to the objective measure used, then perceived risk should increase with number of men committed in decisions by the Ss.

During the simulation Ss committed men by battalion (approximately 3000 men) and decisions committing troops were placed in categories of either 1, 2, 3, or 4+ battalions. A total of 336 decisions made by 62 teams during four periods of play were classified as risky under the criteria stated previously and were used in this analysis. Figure 1 shows the results of the comparison of number of battalions committed with the corresponding subjective level of risk. The relationship between the two risk measures did not reach significance. Table 1 summarizes the data analysis.

TABLE 1

Summary of Analysis of Variance for Comparison  
of Objective Risk With Subjective Risk

<u>Source</u>	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>
<u>Between subjects</u>				
	12.5983	3	4.1994	1.9606
<u>Within subjects</u>				
Error	711.1041	332	2.1419	

A three-way ANOVA (2 x 2 x 4) was performed comparing objective risk and subjective risk by (UNHS vs. FRS) and by period (1, 2, 3, 4). Original risk scores for objective risk were obtained by placing decisions in categories of 1, 2, 3, 4+ battalions. Subjective risk was scored on a scale from 1 to 7. To compare risk by team and by period (and later by percent communication effectiveness), scores were standardized (Z-scores) to obtain equivalent scale units.

The total number of risky decisions made during the game was not equal across periods. Decisions were discarded randomly to arrive at an equal number

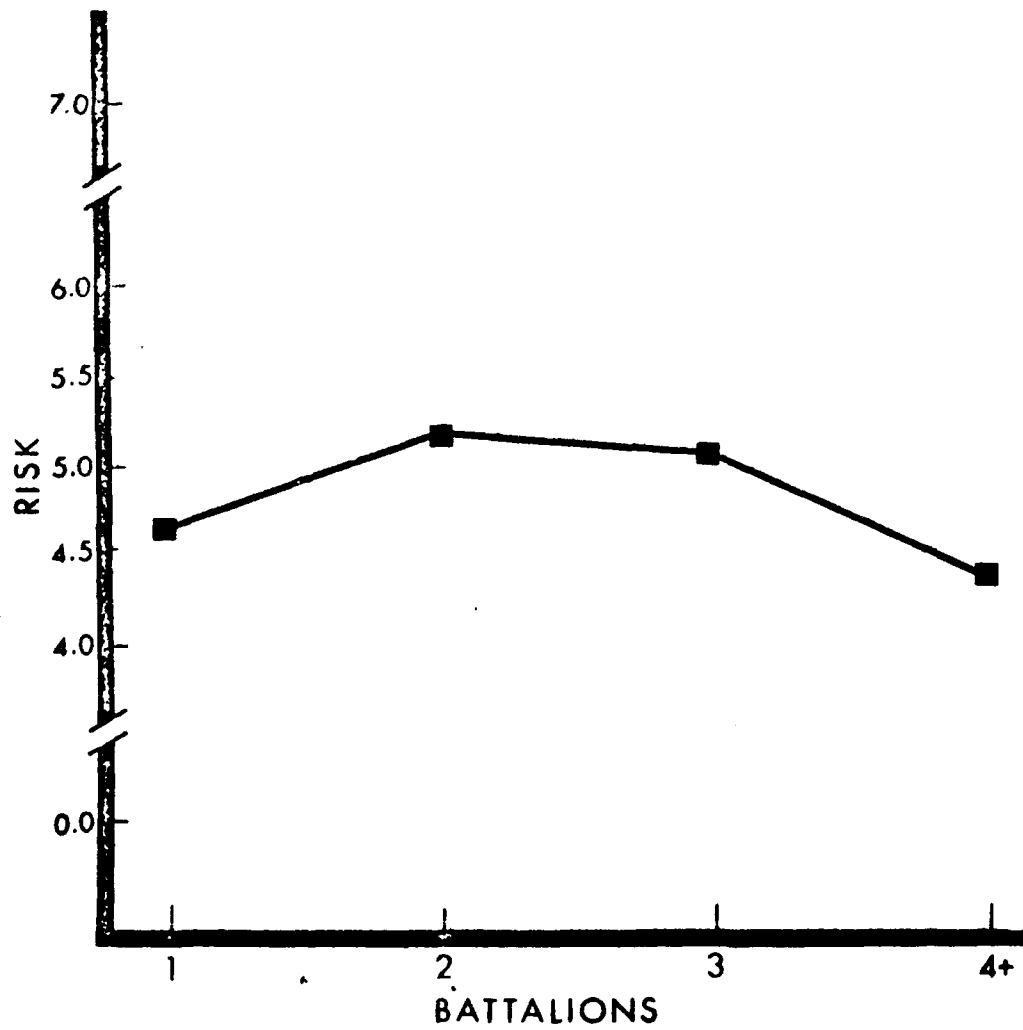


Figure 1. Mean Level of Subjective Risk on a 7-Point Scale as a Function of Number of Battalions Committed in Combat.

per cell. Eighty decisions made by UNHS teams and 80 decisions made by FRS teams were used to assign 20 decisions per cell.

The results indicate a significant main effect due to Team ( $F = 40.4$ ,  $p < .001$ ,  $df = 1,152$ ). There is also a main effect due to Period with levels of risk dropping significantly in the last Period (Period 5) ( $F = 3.02$ ,  $p < .05$ ,  $df = 3,152$ ). Table 2 summarizes the data analysis and Figure 2 illustrates these effects.

TABLE 2  
Summary of Analysis of Variance for  
Comparison of Risk by Team and Period

Source	SS	df	MS	F
<u>Between subjects</u>				
Team	35.0681	1	35.0681	40.419***
Team X Period	.6369	3	.2123	.244
Team X Risk	.8101	1	.8101	.934
Team X Period X Risk	1.4406	3	.4802	.5534
Error	131.8798	152	.8676	
<u>Within subjects</u>				
Period	6.2268	3	2.0756	3.02*
Risk	.8637	1	.8637	1.255
Period X Risk	4.2125	3	1.4042	2.0409
Error	104.5757	152	.6880	
-----				
* $p < .05$				
*** $p < .001$				

To study the effect of manipulation of the communication factor, a three-way ANOVA ( $2 \times 2 \times 4$ ) was performed comparing standardized objective and subjective risk scores by team (UNHS vs. FRS) and by the percent information supposedly communicated (20%, 40%, 60%, 80%) (see Figure 3). One-hundred and sixty decisions were analyzed with 20 decisions per cell.

A main effect due to Team was found in this analysis with FRS teams indicating a significantly higher degree of both objective and subjective risk per decision than the UNHS teams ( $F = 46.6$ ,  $p < .001$ ,  $df = 1,152$ ). The effect for level of information was not significant (see Table 3).

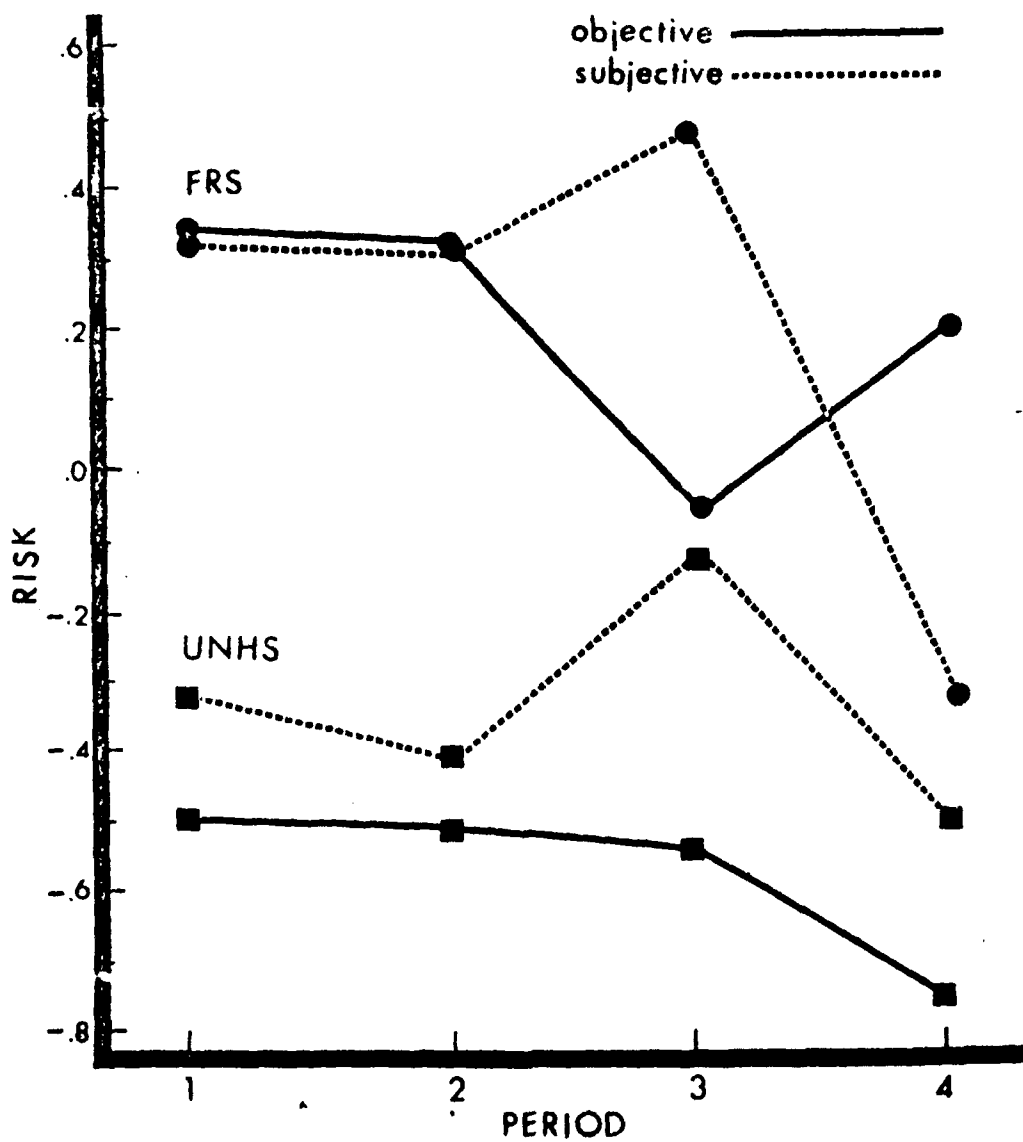


Figure 2. Standardized Objective and Subjective Risk Scores Compared as a Function of Team and Period.

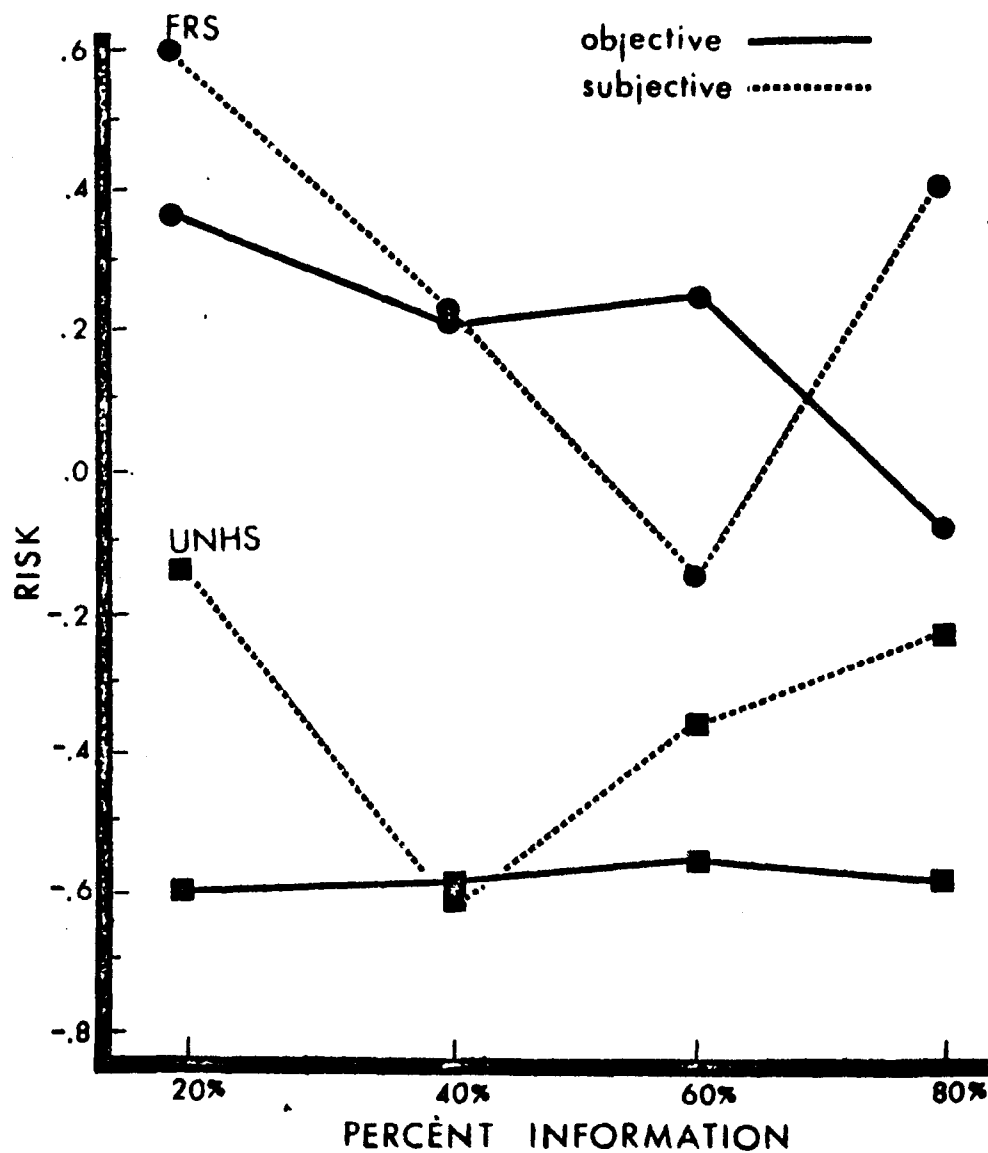


Figure 3. Standardized Objective and Subjective Risk Scores Compared as a Function of Team and Percent Information Communicated.

TABLE 3

Summary of Analysis of Variance for Comparison of  
Risk by Team and by Percent Information Communicated

Source	SS	df	MS	F
<u>Between subjects</u>				
Team	35.5238	1	35.5238	46.61***
Team X Percent	2.1387	3	.7129	.875
Team X Risk	.4019	1	.4019	.493
Team X Percent X Risk	1.8201	3	.6067	.745
Error	123.8041	152	.8145	
<u>Within subjects</u>				
Percent	3.7352	3	1.2451	1.72
Risk	2.0697	1	2.0697	2.86
Percent X Risk	4.0584	3	1.3528	1.87
Error	109.8374	152	.7226	

\*\*\*  $p < .001$

The 31 FRS teams averaged 7.8 decisions per game that met the risk criteria and 31 UNHS teams averaged only 3.03 decisions per game. The difference between these means obtained significance ( $F = 27.85$ ,  $p < .001$ ,  $df = 1,60$ ). Table 4 summarizes the data analysis.

TABLE 4

Summary of Analysis of Variance of  
Test for Mean Number of Decisions Made per Team

Source	SS	df	MS	F
<u>Between subjects</u>				
	425	1	425	27.85***
<u>Within subjects</u>				
Error	916	60	15.28	

\*\*\*  $p < .001$

## DISCUSSION

The results of the one-way ANOVA comparing numbers of men committed (by battalions), in a decision classified as risky, with level of perceived or subjective risk seem to indicate that in the context of this simulation subjects did not feel riskier as they engaged more men in combat.

The results obtained in this experiment are not in agreement with Pruitt's PLR model. It should be noted, however, that the present research shows considerable deviations from Pruitt's experimental design.

Pruitt's model incorporates probabilities and payoff ratios including the definite possibility of a negative outcome associated with all levels of risk. The more severe consequences related to higher variance patterns are considered as being more risky than low variance patterns.

In the present research involving the TNG, however, there are no established objective probabilities associated with a specific situation or numbers of men involved. Subjects are not given win/lose probabilities to consider when making decisions. At the same time negative outcomes or loss factors, related in magnitude to number of men, are not specified.

Because objective probabilities are not given, the subjects are forced to create their own subjective probabilities (expectations) based on available information or known conditions. The data suggest that peak perception of risk may occur more likely when groups of decision makers are committing two battalions. It should be noted, however, that these suggestions are not based on significant shifts in risk perceptions and should be viewed very cautiously. The results imply a possible interaction between probability of losing and cost of losing (cf. Streufert and Streufert, 1968), with the maximum combination potentially occurring where two battalions are engaged in an unknown situation, and the lowest combination occurring with four or more battalions.

It seems reasonable to assume that in many situations the probability of losing an engagement would become less as the number of men increased. If probability functions were given and there was the definite possibility of losing a relatively large army, then Pruitt's variance assumptions would have been tested more precisely. Committing a large army may insure victory more often, but losing a sizable force might present a large negative utility factor.

Subjects were able to increase or decrease the size of both offensive and defensive forces during the course of the game. After considering the content of messages stating that engagements were not going well, subjects would typically either commit additional units or would withdraw and disperse to safety. Thus, the mobility of forces usually could exempt the teams from suffering very severe consequences. In other words, subjects may well have responded to the simulated events with decisions which they viewed as less risky than they actually were since a relatively safe escape seemed inherent in the environmental conditions.

The three-way analysis comparing risk by period indicated a significant decrease in risk level in the fifth or last period. Planned post hoc comparison tests indicate that this drop is due to perceptions of risk, not to actual risk taking ( $p < .05$ ). Possible reasons for this are not immediately evident. The same effect has been found previously (Streufert and Streufert, 1969) where significant decreases in level of risk occurred in this same period (five). In the research cited the simulation was conducted for a total of seven playing periods. Since teams were not aware of when the game would end, it eliminated the possibility of the effect being due to the last period. The possibility that this finding is related to number of decisions made by the teams can also be eliminated (number of decisions per period remained approximately the same during the four periods).

The explanation for this effect might be found in the simulation design rather than in any manipulation. It may thus be a function of time and cumulative experience. As the game progresses, economic and diplomatic considerations by Ss increase. This shift in concentration may be a function of time and the developing game environment. A shift toward greater use of alternate (non-military) strategies may produce a feeling of greater "security" when military decisions are made, resulting in lowered perceptions of subjective risk levels. For example, a population conceived as friendly (because of aid on the economic side) may make troops operating in their areas less endangered. Additional research will be necessary to isolate specific causes.

The percent information communicated factor did not have a significant effect on risk. A possible explanation is that the manipulation may not have been effective enough to cause a significant number of Ss to seriously consider



the communication. Although level of information factors of 90%, 80%, 60%, 40%, and 20% were communicated to the subjects during the five periods of play, they still received ten messages per period. However, this explanation is probably incorrect. In most cases Ss did respond to the communication and frequently (particularly during the 20% and 40% manipulations) sent additional messages with exactly the same content to increase the probability of a message reaching its destination. Another possibility is that the information manipulation modified decision frequency but not risk taking.

Significant differences were found between UNHS teams and FRS teams in both level of risk and in number of decisions made. There were sizable differences between teams in both objective and subjective risk. FRS teams committed more men per decision and at the same time felt or perceived a greater degree of risk in doing so. An examination of the general differences in style of conducting military engagements should explain this effect of Team in the simulation.

The UNHS military position in Shamba, because of control of all major cities, towns, and military bases, was more defensive in nature than the FRS position. The UNHS teams had forces in the important cities throughout the country and their major objective was to retain control of the portions of the country they occupied.

This, combined with the fact that the UNHS did not know exact locations of FRS units, resulted in UNHS teams playing mostly a "waiting game." UNHS teams would wait for FRS activity or offensives and then order troops already in the area to defend the attacked city or installation. The teams would then commit additional units if necessary. Because UNHS teams commanded superior forces, the perception of risk was probably much lower than for FRS teams. Increased mobility and vastly superior air strike capability may have contributed to a low subjective risk factor.

Many of the types of the UNHS decisions described above did not meet the criteria for risky decisions because they were not offensive or did not initiate combat. This mainly defensive style of warfare is evidenced by the relatively small number of military decisions used in UNHS team analysis. In the four periods analyzed, UNHS teams made a total of 20, 25, 23, and 22 decisions. During these same periods, FRS teams made 48, 60, 59, and 54 decisions. The difference was significant.

The FRS military position was the opposite of that of the UNHS forces. The FRS did not control major cities and towns in the country, although they did control various segments of the rural areas throughout Shamba. FRS teams were able to plan offensives at will. The primary tactic of FRS teams seemed to be to commit large numbers of men against an objective and then wait for initial results of the engagement. If results were not favorable, teams would withdraw their units and attack at another location. FRS teams were constantly moving troops throughout the country, attacking various enemy positions and attempting to take control of numerous towns and cities.

This aggressive, offensive strategy contributed to the high number of FRS decisions. An attack on a town or military unit, however, would reveal location and troop numbers to the UNHS forces. Risk of retaliation by larger numbers of men with superior fire-power was high, probably contributing greatly to the perception of risk when initiating attacks against UNHS-held positions.

One should note that the greater number of decisions and the greater number of troops committed by the FRS (objective risk) covaries with greater estimates of (subjective) risk. This finding could not be demonstrated by combining FRS and UNHS data (see Figure 1). In this case, however, the data may be due to a subjective vs. objective risk relationship or due to team (UNHS vs. FRS) condition. Further research appears needed.

#### SUMMARY AND CONCLUSIONS

The failure of the present research to find a clear positive relationship between objective and subjective risk scores illustrates the difficulties encountered when attempting to obtain valid measures with an objective scale of risk. The problems in prediction and correlation demonstrated in studies cited previously (Slovic, 1962, 1964; Kogan and Wallach, 1964) resulted in part from not knowing enough about subjective considerations made by the persons being scaled. Risk scales used in these studies did not include important subjective parameters involved. In the present study some of the same problems may have occurred, and subjects' perception of amount of risk involved in a decision may not have been adequately reflected in the objective measure.

The slight and insignificant decrease in subjective perception of risk when committing more than two battalions suggests a need to isolate the subjective

parameters affecting the decision making, and incorporate these parameters in the objective scale used. It may be found, however, that the subjective parameters are too numerous or complex to make this feasible when constructing a risk scale.

The significant decrease in risk during the fifth period presents some interesting questions regarding the simulation environment and the accrued experiences of the Ss. A detailed examination of the game process and Ss' reactions and learning experiences will be required to answer these questions.

The failure of manipulation of information level to affect perceived risk also suggests the need for further research. It appears that the percent communication effectiveness factor may not have affected the Ss' perception of risk involved. The variables may not be related or the relationship may be more complex than anticipated.

The Team effects found in every analysis appear to be very similar to the differences in military tactics found in South Vietnam between the United States/ South Vietnamese (ARVN) forces and the Viet Cong/North Vietnamese forces. This is especially true when considering the pattern of the war in the years before 1968 when U.S./ARVN strategy changed to a more aggressive ground war. It would be interesting to determine whether the relative differences in subjective perception of risk found in the present research also occur among decision makers for the respective sides in South Vietnam.

The Ss' actions and decisions in the TNG closely parallel those of their counterparts in South Vietnam. The findings of significant differences due to Team in the present research may have practical applications in studying decision-making processes in that country.

#### REFERENCES

- Atkinson, J. W. An introduction to motivation. Princeton, New Jersey: Van Nostrand, 1964.
- Atkinson, J. W., Bastian, J. R., Earl, R. W., and Litwin, G. H. The achievement motive, goal-setting, and probability preferences. Journal of Abnormal and Social Psychology, 1960, 60, 27-36.
- Atkinson, J. W., and Feather, N. T. (Eds.) A theory of achievement motivation. New York: Wiley, 1966.

- Cohen, J. Chance, skill, and luck. Baltimore: Penguin, 1960.
- Coombs, C. H., and Pruitt, D. G. Components of risk in decision making: Probability and variance preferences. Journal of Experimental Psychology, 1960, 60, 265-277.
- Davis, J. H., Hoppe, R. A., and Hornseth, J. P. Risk taking: Task, response pattern, and grouping. Organizational Behavior and Human Performance, 1968, 3, 124-142.
- Edwards, W. The prediction of decisions among bets. Journal of Experimental Psychology, 1955, 51, 201-214.
- Edwards, W. Subjective probability in decision theories. Willow Run Laboratory Report No. 2144-361-T (University of Michigan), 1959.
- Edwards, W. Subjective probabilities inferred from decisions. Psychological Review, 1962, 79, 109-135.
- Edwards, W., and Slovic, P. Seeking information to reduce the risk of decisions. American Journal of Psychology, 1965, 78, 188-197.
- Griffith, R. M. Odds adjustment by American horse-race bettors. American Journal of Psychology, 1949, 62, 290-294.
- Hoge, R. D., and Lanzetta, J. T. Effects of response uncertainty and degree of knowledge on subjective uncertainty. Psychological Reports, 1968, 22, 1081-1090.
- Irwin, F. W., and Smith, W. A. S. Value, cost, and information as determiners of decision. Journal of Experimental Psychology, 1957, 54, 229-232.
- Kogan, N., and Wallach, M. A. Risk taking: A study in cognition and personality. New York: Holt, Rinehart and Winston, 1964.
- Kogan, N., and Wallach, M. A. Risk taking as a function of the situation, the person, and the group. New Directions in Psychology, New York: Rinehart and Winston, 1967, 3, 113-275.
- Lanzetta, J. T., and Kanareff, V. T. Information cost, amount of payoff, and level of aspiration as determinants of information seeking in decision making. Behavioral Science, 1962, 7, 459-473.
- Lichtenstein, S. Bases for preferences among three-outcome bets. Journal of Experimental Psychology, 1965, 69, 162-169.
- Luce, R. D., and Raiffa, H. Games and decisions. New York: Wiley, 1957.
- McGlothlin, W. H. Stability of choices among uncertain alternatives. American Journal of Psychology, 1956, 69, 604-615.

- Munson, R. F. Decision-making in an actual gambling situation. American Journal of Psychology, 1962, 75, 640-643.
- Pruitt, D. G. Information requirements in making decisions. American Journal of Psychology, 1961, 74, 433-439.
- Pruitt, D. G. Pattern and level of risk in gambling decisions. Psychological Review, 1962, 69, 187-201.
- Shuford, E. H. A comparison of subjective probabilities for elementary and compound events. Chapel Hill, N. C.: University of North Carolina, Psychometric Laboratory, 1959.
- Slovic, P. Convergent validation of risk taking measures. Journal of Abnormal and Social Psychology, 1962, 65, 68-71.
- Slovic, P. Assessment of risk taking behavior. Psychological Bulletin, 1964, 61, 220-233.
- Streufert, S., Driver, M. J., and Haun, K. W. Components of response rate in complex decision making. Journal of Experimental Social Psychology, 1967, 3, 286-295.
- Streufert, S., Kliger, S. C., Castore, C. H., and Driver, M. J. A tactical and negotiations game for the analysis of decision integration across decision areas. Psychological Reports, 1967, 20, 155-157.
- Streufert, S., and Schroder, H. M. Conceptual structure, environmental complexity, and task performance. Journal of Experimental Research in Personality, 1965, 1, 132-137.
- Streufert, S., and Streufert, S. C. The effect of information quantity and time spent in military decision making on the degree of risk taking. Purdue University: ONR Technical Report No. 15, 1968.
- Streufert, S., and Streufert, S. C. Risk taking in military and economic decision making: An analysis via an experimental simulation. Purdue University: ONR Technical Report No. 16, 1968.
- Streufert, S., and Streufert, S. C. The effect of conceptual structure, failure and success on attribution of causality and interpersonal attitudes. Journal of Personality and Social Psychology, 1969, 11, 138-147.
- Streufert, S., Suedfeld, P., and Driver, M. J. Conceptual structure, information search and information utilization. Journal of Personality and Social Psychology, 1965, 2, 736-740.

- Suedfeld, P., and Streufert, S. Information search as a function of conceptual and environmental complexity. Psychonomic Science, 1966, 4, 351-352.
- Van der Meer, H. C. Decision-making: The influence of probability preference, variance preference, and expected value on strategy in gambling. Acta Psychologica, 1963, 21, 231-259.